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June 27, 1994

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William F. Caton
Acting Secretary
Federal Communications Commission
1919 M Street, N.W., Room 222
Washington, D.C. 20554

Re: **Notice of Ex Parte Presentation in PR Docket No. 93-61**

Dear Mr. Caton:

Pursuant to Section 1.1206(a)(1) of the Commission's Rules, notice is hereby given of a written ex parte presentation in the above-referenced proceeding. Two copies of the presentation are enclosed herewith as required by the rule.

Please contact the undersigned if there are any questions regarding this matter.

Respectfully submitted,

David E. Hilliard

David E. Hilliard
Attorney for Pinpoint Communications, Inc.

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Enclosures

cc (w/o encls.):
Chairman Reed E. Hundt
Commissioner James H. Quello
Commissioner Andrew C. Barrett
Commissioner Rachel B. Chong
Commissioner Susan Ness
Ruth Milkman
Lauren J. Belvin
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June 27, 1994

Mr. Ralph Haller
Chief, Private Radio Bureau
Federal Communications Commission
Room 5002, Stop Code 1700
2025 M Street, N.W.
Washington, D.C. 20554

Re: PR Docket 93-61
Automatic Vehicle Monitoring ("AVM")

Dear Mr. Haller:

On June 23, 1994, Pinpoint Communications, Inc. ("Pinpoint") and a majority of the parties to this proceeding who have promoted wide-area multilateration Automatic Vehicle Monitoring (AVM) systems filed a paper entitled LMS Consensus Position on Part 15 Interference (the "Consensus Paper"). To a great extent, the Consensus Paper as well as a separate paper filed on June 21 by AirTouch Teletrac reviewed the frequency of interference from Part 15 devices that the Teletrac AVM system has encountered in the six cities in which it has been in operation. As reported in these papers, Teletrac has experienced interference over a 3 1/2 year period from approximately six Part 15 devices per every 100,000 in operation in the Teletrac operating territory. Not a single Part 15 device had to cease operation in order to correct any of the interference situations. For the reasons set forth below, including Pinpoint's experience in operating an experimental AVM system for almost one year, Pinpoint expects that it will experience even less interference from Part 15 operations.

Pinpoint has sought and continues to seek solutions that would reasonably meet the needs of AVM systems as well as Part 15 devices. In this letter Pinpoint reiterates the reasons why its ARRAY™ system is less susceptible to interference than other AVM systems. In so doing, we do not mean to imply that permanent rules should foster Pinpoint's technology without providing an opportunity for other systems. Rather, we note that the presence of system differences should encourage the Commission in its efforts to reach decisions in this proceeding.

Final rules that accommodate a diversity of approaches to AVM will best serve the varying interests of those now depending on AVM systems and the much larger number of persons in the future who will use such systems to travel more safely and efficiently. By providing for a variety of approaches to AVM, the Commission will also encourage system proponents to deal with the effects of other users in the 902 - 928 MHz band.

Pinpoint Differences

There are two principal reasons why the ARRAY™ system is less susceptible to interference than other wide-area AVM systems that have been described in this docket. First, the ARRAY™ system was designed from the outset to take into account relatively high levels of interference that were expected over time from Part 15 devices and other users of the 902-928 MHz band.[1] Second, the ARRAY™ system was designed to perform a position fix in a minimum amount of time, which achieves two important goals. Obtaining a position fix in a minimum time: (a) provides considerably higher vehicle location capacity (from 1,500 to 3,000 per second depending on the usage of the system, but not accounting for possible frequency reuse), and (b) statistically reduces the probability that the radiolocation signals and the interfering signals are "on the air" simultaneously — a benefit that gives the radiolocation system much greater flexibility in managing the effects of sporadic interference and sharing the band with Part 15 devices and certain types of AVM systems.

When developing its system, Pinpoint recognized that the 902-928 MHz band was a shared band. Pinpoint knew that it would not only have to share with other AVM systems, both wide-area and local-area systems (such as automatic toll collection reader-tag systems), but that it would, as a practical matter, have to be able to tolerate reasonable levels of noise from Part 15 devices, including relatively high powered spread spectrum devices such as a new generation of cordless phones. Propagation, noise, and interference level survey measurements were conducted in 1991 in the cities of Chicago, Dallas, Houston, and Cincinnati with results that were consistent with those shown in the Consensus Paper.

The ARRAY™ system was designed to operate in the presence of projected interference levels, which are considerably higher than those measured today. While the current spectrum interference levels are still relatively quiet, as shown in the Appendix of the Consensus Paper, Pinpoint assumed that, over time, there would be many more users of the band, and hence

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[1] Design of the ARRAY™ system began shortly before the revised Part 15 spread spectrum rules became final in 1991.

significantly higher average levels of interference from those users.[2] Pinpoint's link analysis determined that with such interference levels, its system would have to operate over relatively short ranges and with relatively higher transmit powers. The ARRAY™ system architecture of a mature installation will be characterized by base station separation on the order of five to seven miles. The density of base stations in the ARRAY™ network is thus considerably greater than that of the other wide-area AVM systems, which have discussed operating ranges on the order of twenty miles. Pinpoint could operate over similar ranges in a pristine radio environment,[3] but reality forces operation that is interference limited, rather than constrained only by thermal noise.

Interference is a Matter of Spatial and Temporal Probability.

System-wide, more base stations may at first suggest that there are more antennas that could receive a Part 15 signal. In actuality, the use of a larger number of base stations lessens the probability of overall system performance degradation. Thus, as a result of the shorter distance to a base station, more base stations are likely to be involved in any given position determination. To determine a vehicle's location, a radiolocation pulse from the vehicle's transceiver will be received by a group of nearby base stations, typically six to eight in number, termed a "cluster." A minimum of four base stations is necessary to achieve an accurate location determination. (The stations that comprise a "cluster" are selected dynamically, depending upon the actual location of, and propagation condition around, the vehicle to be located.) Even if the position fixing pulse from the vehicle is not received by one or two base stations due to local interference -- such as that which might be created by a Part 15 device's operation, or conceivably the operation of a local-area reader-tag AVM system -- the Pinpoint system will continue to function satisfactorily. Additionally, the Pinpoint system does not operate on "raw" time-of-arrival data. Rather, in calculating position, it screens location-timing data of the incoming received pulses for significant distortion due to interference or severe multipath propagation, by correlating all the data from a cluster. Furthermore, the short duration of a position fix's signal reduces the probability of a sporadic interfering signal and a radiolocation signal colliding at the same time and at enough base stations in a cluster to prevent a useful position fix from being determined by the system.

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[2] Pinpoint also reasoned that many of these users would be on the air only sporadically, and designed its radiolocation system to be able to tolerate varying levels of interference, depending on the duty cycle of the interfering signals. This was reflected in the graded interference levels ranging from -70 to -90 dBm depending on duty cycle, described in Pinpoint's March 29, 1994, reply to comments on Teletrac's ex-parte presentation to the FCC on a revised band plan submitted earlier this year.

[3] Pinpoint's receiver sensitivity levels are actually much lower than the interference levels, such that the receiver could provide reliable position fix timing in a thermal noise limited environment down to levels of about -112dBm.

Near-Far Effects

The use of a larger number of base stations also means that the "near-far" problem can be managed more advantageously. Interference results when an unwanted signal is sufficiently strong to impair the reception of a desired signal, such as a mobile unit's location pulse. Part 15 devices will likely operate with less radiated power than the Pinpoint AVM mobile unit. Nevertheless, it is conceivable that a Part 15 device could cause interference if it were sufficiently close to one of the AVM base antennas while the mobile unit were far enough away to make the AVM (desired) signal inordinately weak as compared to the Part 15 (interfering) signal. By increasing the density of base stations, the AVM system can reduce the probability of adverse near-far effects (which typically will only occur near the interfering source). Thus, at many of the other base stations in the cluster, the near-far situation would be reversed (*i.e.*, the mobile is nearer and the interference is farther). Accordingly, the strength of the AVM signal will be more likely to be sufficiently strong to overcome the adverse effects of the "interfering" signal at enough of the other base stations in the cluster.

Shorter Transmission Time

As mentioned earlier, the other principal distinguishing characteristic of the ARRAY™ system for purposes of the present discussion is the ability to locate vehicles in a minimum amount of time. This characteristic is largely the product of the wider bandwidth utilized by Pinpoint -- up to 16 MHz versus the 4 MHz currently used by other systems. The higher speed signalling feasible in such a bandwidth significantly reduces the time to perform a fix, making Pinpoint's network significantly less susceptible to sporadic interference. First, because it takes less time (up to two orders of magnitude difference) to complete a vehicle location transaction on the ARRAY™ network, the probability that a given location determination will be interfered with by a sporadic Part 15 device is significantly less. Second, if there is interference to a particular location determination, less time is lost by repeating the operation. In short, by recognizing that the band was shared, Pinpoint designed a system that in exchange for spreading its signal over a wide bandwidth, reduces the amount of airtime and achieves tangible robustness benefits.[4]

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[4] Pinpoint achieves another benefit by using wider bandwidth even though it recognizes that the price of employing such a wide signal is the accommodation of other users. The wider bandwidth significantly improves the ability of the system to overcome multipath distortion so common in the urban and suburban areas in which wide-area AVM systems are to be operated. Multipath distortion combines with interfering signals to exacerbate any system degradation that may be experienced. By significantly reducing multipath distortion, Pinpoint effectively reduces even further the inaccuracies occasioned by interference.

Effects on Others

The increased density of base stations also minimizes the effect of Pinpoint on other users of the band. The dynamic "cluster" arrangement is complemented by a dynamic selection of which base station communicates with a given mobile vehicle. Thus, the system does not simulcast the base-to-mobile signal on all base stations. Rather, any of the base stations in a mobile's "cluster" can transmit a poll or message to a mobile, although only one at a time will do so. As a result, any given base station in a market has an extremely low transmit duty cycle, usually on the order of 3 percent or less. Because of the dynamic nature of selection of the transmitting base station, the system selects a different base to communicate with a mobile when a particular base-to-mobile link is affected by interference.

Operating Experience

Unlike Teletrac, Pinpoint received its first station license only in the latter part of last year and does not yet have any commercial systems in operation, in significant part due to the uncertainty engendered by the continuation of this rulemaking. However, since August of last year, Pinpoint has operated an experimental system in Washington D.C., and Arlington, Virginia, on an almost daily basis using four, and sometimes five, base stations. This experimental system is arranged in a minimal cluster architecture, but the base stations and mobiles are operating at power levels Pinpoint intends to use in its mature commercial operations.[5] As noted earlier, a cluster will typically consist of at least six to eight base stations and is defined relative to a mobile unit at a given point of time within a system that may includes several times as many base stations overall.

To date, Pinpoint has not experienced any interference from Part 15 devices interrupting the vehicle location capability of its experimental system. While, on occasion, there has been momentary interference at one of the base stations, this does not affect the *overall system* operation. Conversely, Pinpoint has not received any complaints of interference to Part 15 devices.

This lack of interference from Part 15 devices or complaint of interference by users of such devices is particularly significant as several of the base stations are located either *on* or very close to apartment complexes or office buildings. Indeed, Pinpoint has also learned that there are significant numbers of utility operated automatic meter reading devices in the vicinity

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[5] Specifically, Pinpoint's experimental system uses base stations operating at approximately 500 watts ERP and mobile units at about 40 watts ERP. Pinpoint has urged the Commission to provide for higher base station power to compensate for increasing interference noise levels over time, but believes it can operate successfully with 500 watt ERP base stations. Furthermore, while the Pinpoint mobile transceiver power is several times greater than other wide-area AVM system mobiles, transmission time is at least an order of magnitude shorter.

of some of the base stations. In a meeting four weeks ago, the utility company's representatives stated that they were surprised to learn that Pinpoint has had an experimental system in operation for almost a year, as their operations have not suffered from its presence.

Part 15 Testing

From preliminary observations made with Part 15 devices purchased "off the shelf," Pinpoint believes that most typical uses will create only a negligible interference hazard to the ARRAY™ system. Moreover, Pinpoint has expressed its willingness to conduct field tests with a leading proponent of a Part 15 data distribution systems and a leading manufacturer of automatic meter reading systems. In both cases, Pinpoint's engineers and those of the other party have met to discuss candidly the possible parameters of such a test. However, the parties have thus far been unable to make such tests. In one of these cases, the parties were unable to conduct the tests because they failed to reach agreement on whether there would be public disclosure of the results, with the Part 15 interests expressing concern that any report could lead to unwarranted generalizations and a false sense of compatibility if the respective systems appeared to be compatible in the test. Pinpoint acknowledges the need to report accurately the results and limitations of any test, but also believes that, if tests are conducted, the results of such tests should be made available to the Commission.

Testing with Local-Area AVM

While unable to conduct a test with a Part 15 manufacturer, Pinpoint has been able to engage in testing with another entity operating at higher power levels than unlicensed devices with whom it would share the 902-928 MHz band, namely AMTECH Corporation. AMTECH is a manufacturer of local-area reader-tag systems such as those employed on toll roads and by North America's railroads. In this test, AMTECH installed a temporary tag reader on the George Washington Parkway near the entrance to Ladybird Johnson Park. The AMTECH tag reader had an effective radiated power of approximately 10 watts ERP with a 10 dB gain antenna located about 8 feet above ground and directed down toward a lane of traffic.

Testing with AMTECH revealed that the Pinpoint system could tolerate interference of the type likely to come from local area AVM systems with minimal effects, which could be dealt with efficiently in the processing of the location data. Similarly, the AMTECH system continued to read the tag from a vehicle equipped with an operating Pinpoint radio as that vehicle was driven past the reader. The Pinpoint system, while operating with the AMTECH reader, was shown to FCC officials in October of 1993. The results of the experimental operation and a description of the experimental system were discussed in a report prepared by Hatfield & Associates of Boulder, Colorado, which was filed in this proceeding on January 24, 1994.

The results of this test are important because most consumer and many commercial Part 15 devices will have significantly lower ERP than the AMTECH readers and will be operated indoors most of the time. Pinpoint thus expects very little adverse effect from such systems, which is consistent with its operating experience to date. Near-far differences and in-building propagation attenuation, as well as duty cycle variations, should all combine to make interference to Pinpoint's AVM system unlikely.

A Threshold Is Not an Absolute Limit.

Each wide-area AVM system proponent has differing approaches to wideband pulse-ranging multilateration vehicle location. Each system will respond to Part 15 signals in varying ways depending on the strength and nature of both the Part 15 signal and the AVM signal as well as the AVM system architecture. The Consensus Paper sets forth an agreement among the majority of AVM system proponents for a threshold. Pinpoint concurs in the proposed threshold, and supports requiring AVM licensees to negotiate with unlicensed users in order to resolve interference to the AVM systems. In this respect, it is important to note that the threshold level does not necessarily mean that a Part 15 user must reduce its signal below the threshold. As explained in the "Reply Comments of Pinpoint Communications, Inc. on Comments on Ex Parte Comments" filed March 29, 1994, signals ranging from -90 dBm to -70 dBm could be tolerated by its system on a sliding scale based on duty-cycle time. Thus, Pinpoint would expect to accommodate interference levels that are from one to two orders of magnitude greater than those that could trigger discussions with Part 15 interests under the consensus proposed threshold.

System differences notwithstanding, this proceeding and the experience of those companies who have worked to bring the benefits of wide-area multilateration technology to the American public illustrate that there is a sound basis for believing that the concerns of both the Part 15 interests and those of the AVM industry can be accommodated. Both may make use of the 902 - 928 MHz band in a manner consistent with sound spectrum management that meets the letter and spirit of the Communications Act.

Unless and until these interference issues are resolved, however, the uncertainty surrounding use of the band will delay the deployment of a variety of technologies that hold great promise for enhancing the safety and efficiency of the ways in which Americans use our

streets and highways. Pinpoint urges the Commission to move forward toward decisions in this proceeding that accommodate it and other wide-area and local-area AVM technologies as well as Part 15 devices. Both band plans and interference criteria should strive to meet these objectives.

Respectfully,

David E. Hilliard

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Edward A. Yorkgitis, Jr.
Counsel for Pinpoint Communications, Inc.

Michael A Lewis

Michael A. Lewis
Engineering Policy Advisor for
Pinpoint Communications, Inc.

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